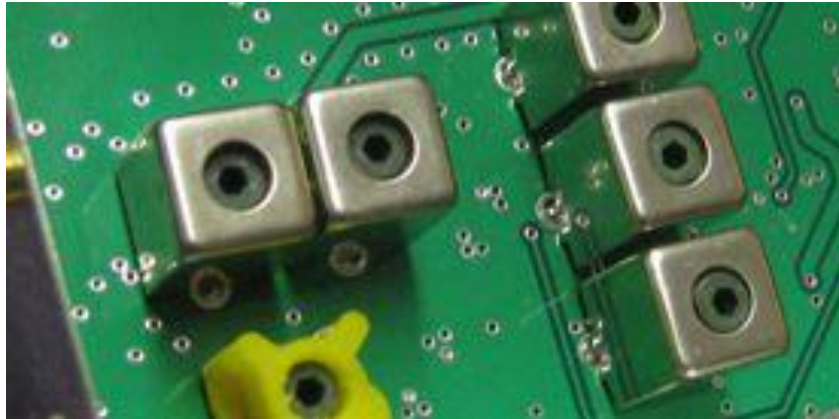


The Anglian 144MHz transverter

A 144/28MHz transverter featuring a high dynamic range receive converter and spectrally clean transmit converter.

document issue V1.1



Introduction

In 2013 I produced a design for a 70MHz transverter, featuring small size and low cost together with high performance. A large number of the 70MHz Nacton kits have been built by radio amateurs. The design won a 'highly recommended' in the designer section of the construction contest at the RSGB Centenary Convention.

I glibly said that the same design could be used on 144MHz, requiring only changes to the RF path and local oscillator component values. In practice this turned out not to be as simple as expected. Although the 144MHz Nacton transverter worked, its performance was not as good as I had hoped. John, G4SWX, built up a couple, intending to use them for EME with polarity diversity, but soon discovered that it would need a few filtering improvements as well as some other changes. The new design, based heavily on the Nacton, is slightly smaller, fits neatly into a standard tin-plate box for screening and in some areas features better performance than the Nacton.

The new transverter has been called the Anglian.

This article describes the 144MHz Anglian transverter.

Anglian description

The Anglian 144MHz transverter converts 28 to 30MHz transmit signals to 144 to 146MHz. On receive 144 to 146MHz signals are down converted to 28 to 30MHz. Based on measurements of early Anglian 144MHz transverters the performance is shown in table 1

Parameter	Performance
<i>Receive converter</i>	
Noise figure	1.6-1.8dB
Gain	24-25dB
Input third order intercept (IIP3)	+0.5 to +1.5dBm
Image rejection (88MHz)	>70dB
<i>Transmit converter</i>	
Power output (Saturated/P1dB)	+22/+20dBm
Transmit gain (Max)	20dB
Drive required for +20dBm output	0dBm (-20dBm with simple modification)
Harmonic output (2nd/3rd/higher)	-40dBc/-50dBc/<-60dBc
Image frequency output suppression	>70dBc
LO suppression	>70dBc

Table 1 Performance of the Anglian 144MHz transverter

Independent measurements of the transverter performance confirms that the performance numbers are real and not just taken from device data sheets. Running some well known signal system analysis programs can give misleading results, especially since multiple stages are involved. During development of the Anglian a number of important lessons were learnt about measurements, particularly where PHEMT active devices are used. Measurement of IIP3, for example, is far more critical than may be realised.

Surface mount technology (SMT) is used for reproducibility. Moderately sized 0805 passive components have been used throughout, with slightly larger types used where necessary for reasons of dissipation or availability.

For anyone buying the Anglian kit, it is supplied as an assembled PCB. The PCB uses 1.6mm FR4 PCB material. The PCB should be seam soldered into the supplied 60mmx 100mm tinplate box used for screening and protection. SMA female connectors are supplied for RF and IF inputs and outputs and feed-through capacitors are supplied for all power and control connections. The PCB was produced by G7OCD.

Mixer and local oscillator

Please refer to the schematic circuit diagram in Appendix 1 for component designations.

An ADE1H level 17 (+17dBm local oscillator) mixer, MX1, is at the heart of the transverter. The mixer is used bilaterally, that is it is used both as the receive down conversion mixer and the transmit up conversion mixer. This arrangement economises on the use of expensive high level mixers and simplifies the local oscillator arrangement.

A two stage Butler overtone crystal oscillator (LO), consisting of TR1 and TR2, operates at 116MHz.

$$144\text{MHz} - 28\text{MHz} = 116\text{MHz}$$

As the crystal oscillator in the basic Anglian transverter is not temperature stabilised and oscillator stability is now crucial for most digital applications, provision is made to inject an external 116MHz local oscillator signal, where required. Alternatively a simple crystal heater can be used to increase the stability of the on-board oscillator by holding the crystal around 40°C.

In order to increase the LO drive from the 0dBm that the oscillator alone provides a PHEMT amplifier, IC5, is used to increase the 116MHz LO output to over +20dBm.

An on-board +8V voltage regulator supplies both the LO and LO amplifier to ensure frequency stability is not affected by any changes in supply voltage as a result of changing current consumption between transmit and receive.

A diplexer is used between the LO amplifier output and the mixer LO input port. It might appear at first sight that the diplexer is connected the wrong way round, however its purpose is to absorb any unwanted products generated by the mixer and reflected back towards the LO amplifier. These products can reduce mixer performance and are best removed. A 0 Ω resistor (bridge), R14, is provided between the diplexer and the mixer to allow the LO level to be accurately set up and measured prior to the mixer. Probe measurements at this point can be misleading due to the complex mixer LO port impedance. The diplexer values were carefully chosen to maximise performance and yet exhibit low loss to the 116MHz LO drive. A clean +20dBm is available to drive the mixer. Although this is higher than the nominal mixer LO drive level for the ADE1H it does improve the mixer IMD performance without causing any adverse effects.

Transmit section

Separate intermediate frequency (IF) connections are provided for the 28MHz transmit drive and receive converter output. Details are given later for alternative arrangements.

As designed the Anglian transverter can accept up to about 2W of 28MHz transmit IF drive. This amount of drive is not recommended as it generates unwanted heat as dissipation in the 'dump' load. It is also possible that unwanted 28MHz pick up at the transmit output port may lead to some unwanted 28MHz radiation. An IF transmit drive level in the range 0dBm to +27dBm is recommended.

The 28MHz (28 to 30MHz) transmit IF input is connected via the IF input connector to a variable π attenuator consisting of the two 120 Ω 1W resistors, R24 and R25, in parallel followed by a series 100R resistor (R26) and then a 500 Ω variable resistor, R27, to ground. Output taken from the wiper of this surface mount variable resistor is connected through a BAP64 PIN diode, D4, to the IF diplexer C17, C19, L4 and L7 on the ADE1H IF port. This diplexer provides a good match to the mixer IF port whilst absorbing any unwanted mixer products. Control of the BAP64 diode is covered later in the section on transmit/receive switching.

The minimum insertion loss of the variable attenuator is about 15dB and over 30dB at maximum attenuation, such as might be required if you really want to heat the two 120 Ω load resistors!

With 0dBm IF transmit input and the variable attenuator set to minimum attenuation (15dB) the mixer IF port is driven well below its maximum level. Consequently the output spectrum is extremely clean, although accompanied by the image and LO frequencies. These are later removed by the main band pass filter (BPF).

The mixer conversion loss measures slightly less than 7dB, resulting in a 144MHz output of approximately -22dBm. The following three pole band pass filter (BPF) has an insertion loss of

about 2.5dB and a 1dB bandwidth of just over 4MHz. The 3dB bandwidth is about 6MHz. Note that no diplexer or other matching loss is inserted between the mixer and the BPF.

After switching in a second BAP64 PIN diode, D5, the wanted 144MHz transmit signal is amplified to around 0dBm in another PHEMT amplifier, IC7. The 88MHz image and 116MHz LO are suppressed well over 50dB at this point.

A two stage BPF in the transmit path further filters the output spectrum so that the image and LO frequencies are now suppressed well over 70dB with respect to the wanted output at 144MHz.

A second transmit PHEMT amplifier stage, IC8, is used to amplify the 144MHz filter to +20dBm. Increasing the 28MHz IF drive input to +3dBm results in the 144MHz output stage saturating at about +22dBm. The exact levels depend on how well the filters have been tuned. The specified Mitsubishi RF MOS amplifier module requires around +10dBm for full output at 144MHz.

A low pass filter consisting of C71, C72 and L19 at the Anglian transmitter output reduces harmonics to a low level prior to driving the following power amplifier.

Receive converter

144MHz band received signals enter the converter and pass through a noise matching circuit consisting of C45, C46, C47, C48 and L20 and into an SPF5043 low noise, high dynamic range PHEMT amplifier, IC6. This stage provides around 22dB of gain with a noise figure of 0.8dB (when added to the insertion loss of the noise matching filter). The SPF5043 has an output third order intercept (OIP3) of +30dBm at 144MHz.

A BAP64 PIN diode, D6, switches the receive path to the following three stage BPF. This is the same BPF used in the transmit path. BAP64 PIN diodes were chosen because of their good IMD performance. They have been carefully biased for optimum performance.

After the BPF the ADE1H mixer frequency converts the signal down to 28MHz where the IF port diplexer ensures a good match to the mixer.

Another BAP64 PIN diode, D3, then switches the 28MHz receive IF to a very high dynamic range PHEMT post mixer amplifier, IC4. The MGA30689 has an OIP3 of +40dBm at 28MHz with a noise figure of less than 3dB. Its gain is flat from below 40MHz to over 3GHz at 14dB, with an excellent input match to 50Ω. It is a truly remarkable device.

A 29MHz bandpass filter consisting of C21, C22, C23, C24, C25, L1 and L2 suppresses any feed through of 116MHz local oscillator or other unwanted out-of-band signals from reaching the following 28MHz IF receiver.

Transmit/receive switching

The Anglian transverter can be switched between receive and transmit in two ways. The usual method is to apply an earth (ground) to the PTT input. The over-coax method is not often used with a 28MHz IF, although it is well suited to switching over a long IF interconnection where the switching relies on the presence of the IF coax connection. If this accidentally becomes disconnected the Anglian transverter cannot be accidentally switched to transmit, so it provides a useful failsafe facility.

Connecting an earth to the PTT input causes the transistor TR4 to switch on and supply +12v to voltage regulator IC3 which in turn supplies +5v to the two transmit amplifier stages, IC7 and IC8. TR4 in switching on turns TR5 off via the Zener diode D2. TR5 removes volts from voltage regulator IC2 which stops supplying the receive RF stage IC6 and post mixer amplifier IC4, thus switching them off. The same voltage regulators supply the four PIN switching diodes D3, 4, 5, and 6, switching the appropriate transmit or receive path on or off.

If over-coax switching is required a small positive voltage on the inner of the transmit IF coaxial cable, at the HF radio, will switch TR3 on. This in turn switches TR4 on, which is similar to the action of grounding the PTT input. From here the switching is identical to PTT input switching.

TR6 is a MOSFET switch that is switched on via TR4 when the Anglian is switched to transmit. The resistors R31 and R32 ensure that TR6 is held off until the voltage from the collector TR4 rises high enough to switch. On receive there is a small positive voltage on the collector of TR4 and these resistors ensure the voltage is 'potted' down sufficiently to hold TR6 off during receive. TR6 drain output provides a convenient ground connection to enable (turn on) an external linear amplifier requiring earth on transmit (EOT). The +12VTX_OUT provides a positive 12volt output to switch a small external antenna relay from receive to transmit.

The 5VTX_OUT is provided as bias to enable the RA07H0608M 7W power amplifier module. (described separately.)

5VRX_OUT can be used to power an external preamplifier, if required. Note that a BSV52 has been used in place of a BC847 in the TR4 position.

Construction of the Anglian transverter

A double sided FR4 PCB of 60mm x 100mm is used to accommodate the transverter. It is highly recommended that the transverter is seam soldered into the recommended tin plate box to provide screening and protection for the small SMD parts used in its construction. Four M2.5 mounting holes are, however, provided in the PCB to enable the PCB to be mounted onto a base-plate if the tin plate box is not required.

The external LO connection and the 144MHz transmit and receive connections are located at one end of the board and the 28MHz IF connections at the other end. All of the DC input and output connections are also located at the IF end of the PCB. Small (2mm hole)1500pF feed-through capacitors are used to decouple all of the DC connections into and out of the screened box. All SMD parts are on one side of the PCB whilst the HC43/U 116MHz crystal, Q1, and tuneable Coilcraft coils L14, L15, L16, L20, L21 and L22 are located on the other side of the PCB, together with the series diode 1N5401 used to drop the supply volts and provide reverse polarity protection. Due to a PCB tracking error, D1 is omitted from the PCB and the leaded 1N4148 diode should be soldered directly between the feed-through capacitor and the COLLECTOR connection of TR3.

How to assemble and align the Anglian 144MHz transverter.

Introduction

Unlike previous kits from G4DDK, the Anglian 144MHz transverter comes with the transverter PCB ready-populated with nearly all the surface mount components (SMC) required for a fully working transverter. The PCB should be seam-soldered into the prepared tinplate box, used to screen and protect the transverter.

After soldering (or bolting) the five RF SMA connectors to the box, together with the power and control feed-through capacitors, the kit builder then only has to solder three small trimmer capacitors on the component side of the PCB, the crystal and six tuneable coils on the other side of the PCB. It is also necessary to solder a couple of leaded diodes between the PCB and the feed-through capacitors on the box.

Supplying a ready assembled PCB eliminates the need for the kit builder to solder over 100 tiny surface mount components onto the PCB. Pick and place and reflow soldering techniques are used to populate the supplied Anglian PCB.

Because much of the effort required to solder together the transverter is eliminated the builder can be sure that the transverter will work first time. Pre-assembly work like this inevitably increases the cost of the kit, but the builder no longer has to buy lots of SMD parts in order to use just a few, because one-off resistors and capacitors can still be difficult to source.

The Anglian board

The Anglian transverter kit is supplied as an SMD populated PCB together with a number of additional components. The kit builder only needs to solder the board into the tin plate box, fit the connectors and feed-through capacitors, solder the three trimmers, the six tuneable coils and one crystal onto the board and solder two leaded diodes into place.

Prior to delivery the board has been visually inspected under a microscope and basic DC checks have been done to ensure that the board should work when the remaining components are added. This is not a complete guarantee that the PCB is fully functional as the remaining components are needed to test it fully.

Let the building begin

The kit builder should ensure that they have a static-free place in which to work. Antistatic matting and wrist straps should always be used when working with small parts (and large ones too!).

A suitable insulated or grounded, temperature controlled, soldering iron should be used.

Although the populated board has been reflow soldered with unleaded solder paste, the leaded coils and crystal can be soldered using leaded solder, if preferred. Similarly the board can be seam-soldered into the box using leaded solder, as can the SMA connectors and feed-through capacitors.

If any surface mounted components are to be replaced at any time it is recommended that unleaded solder is used. Small SMC rework kits are available from the main component distributors.

The order of work in building the kit is:

1. Inspect the populated PCB for visible damage incurred in transit. Return the board if any damage is found.
2. Mark the tinplate box and drill holes where required
3. Mark the position of the PCB inside the tinplate box
4. Seam solder the PCB into the box
5. Solder the three trimmers, 6 tuneable coils and the crystal onto the PCB
6. Solder the connectors and feed-through capacitors into the holes previously drilled
7. Solder the SMA connector spalls to the PCB RF and IF tracks
8. Wire the feed-through capacitors to the correct PCB pads
9. Solder the two diodes between the appropriate feed-through capacitors and PCB pads
10. Inspect your handy work and clean up any excess flux around the seam soldering, connectors and feed-through capacitors.

Each of these steps is described in the following section.

Inspect the PCB

Use a magnifying glass or microscope to inspect the PCB for unintentional damage. If you spot any and can't fix it yourself, it will be necessary to return the board for repair or replacement. Boards that have been soldered into the box and then reported as damaged will be considered on a case by case basis for obvious reasons!

Marking the box

Carefully examine **photo 1**. The box has two overlapping edges. The PCB has two corresponding cut outs that clear these overlapping edges. This shows which way up the PCB should be mounted into the box

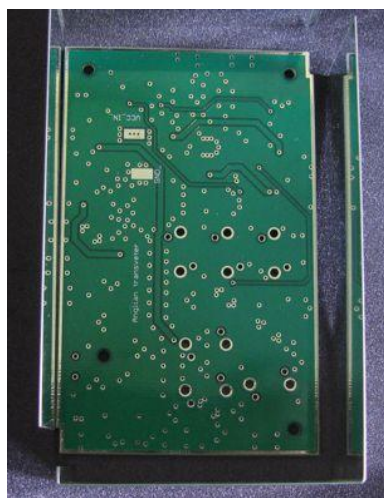


Photo 1. note the cut outs at the top right and lower left of the PCB. These should correspond with the overlapping edges of the tinplate box. Note that an unpopulated PCB is shown in these photos.

Mark the insides of the box, above the PCB, 'UP' with a marker pen, so these cannot be confused in the next step.

With the two sides as shown in **photo 2**, using a Vernier, mark a line all the way around the inside of the box sides. The line should be 22mm below the rim of the box **UP** side.

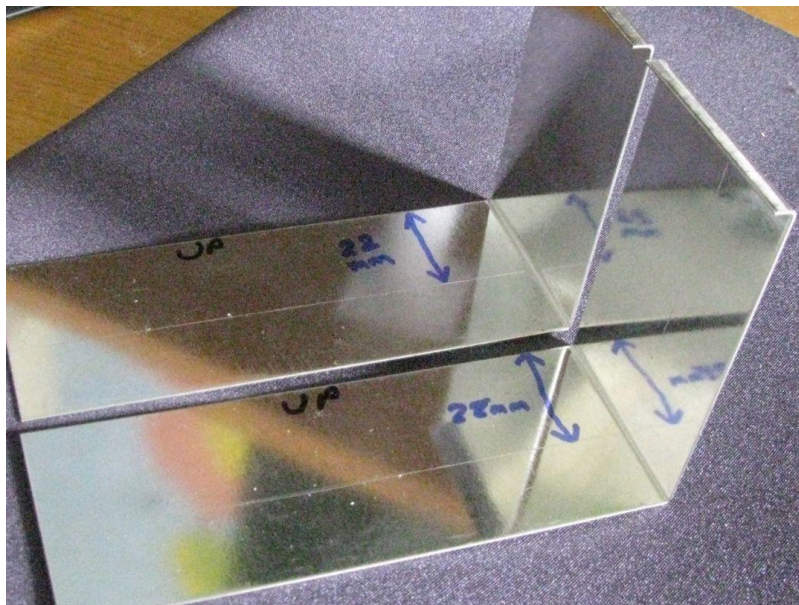


photo 2 inside box sides and ends marked identically, 22mm below the rim of the box. This will be the line to which the PCB will be seam-soldered into the box, after the holes are drilled.

Hold the **IF input** end of the PCB up to one end wall and mark the location of the IF control connector pads and RF connector pads onto the box with a scribe. The control marks should be 24.3mm below the same rim as the 22mm lines. These are most easily marked by resetting the Vernier to 24.3mm and marking a second line inside the end wall only. NOT on the sides!

A third line should now be marked AT THE IF END ONLY. This should be 30mm below the top rim. This line marks where the position for the 2mm holes for the feed-through capacitors.

This is shown in **photo 3**.

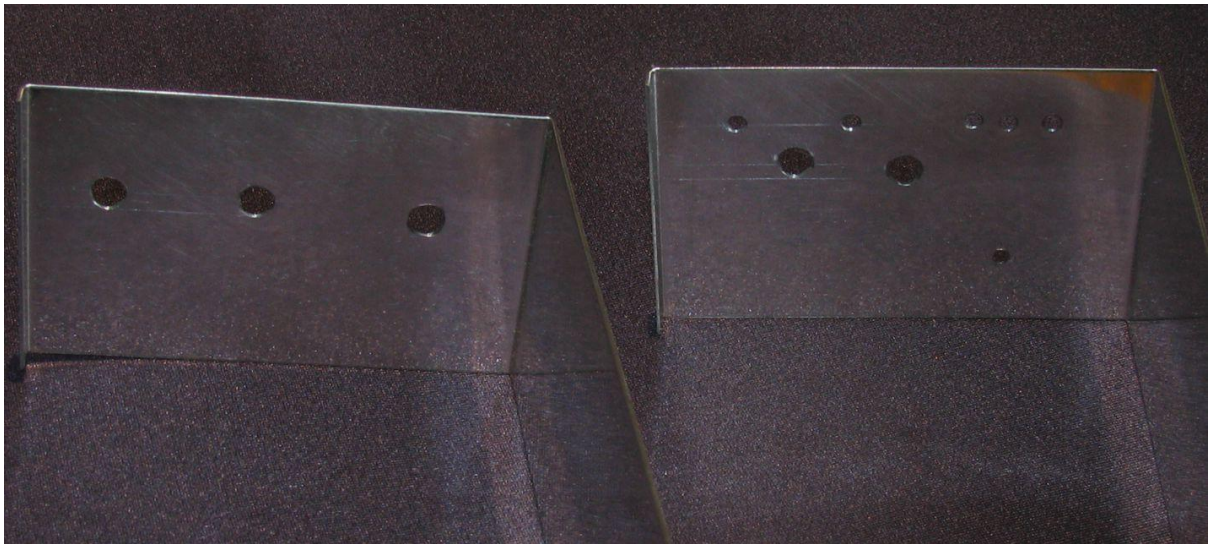


Photo 4 holes for the connectors (4mm) and feed through capacitors (2mm) in the box end walls.

Seam soldering

Offer up the populated PCB to the side of the box with the holes for the IF and feed-through capacitors. This is shown in **photo 5**.

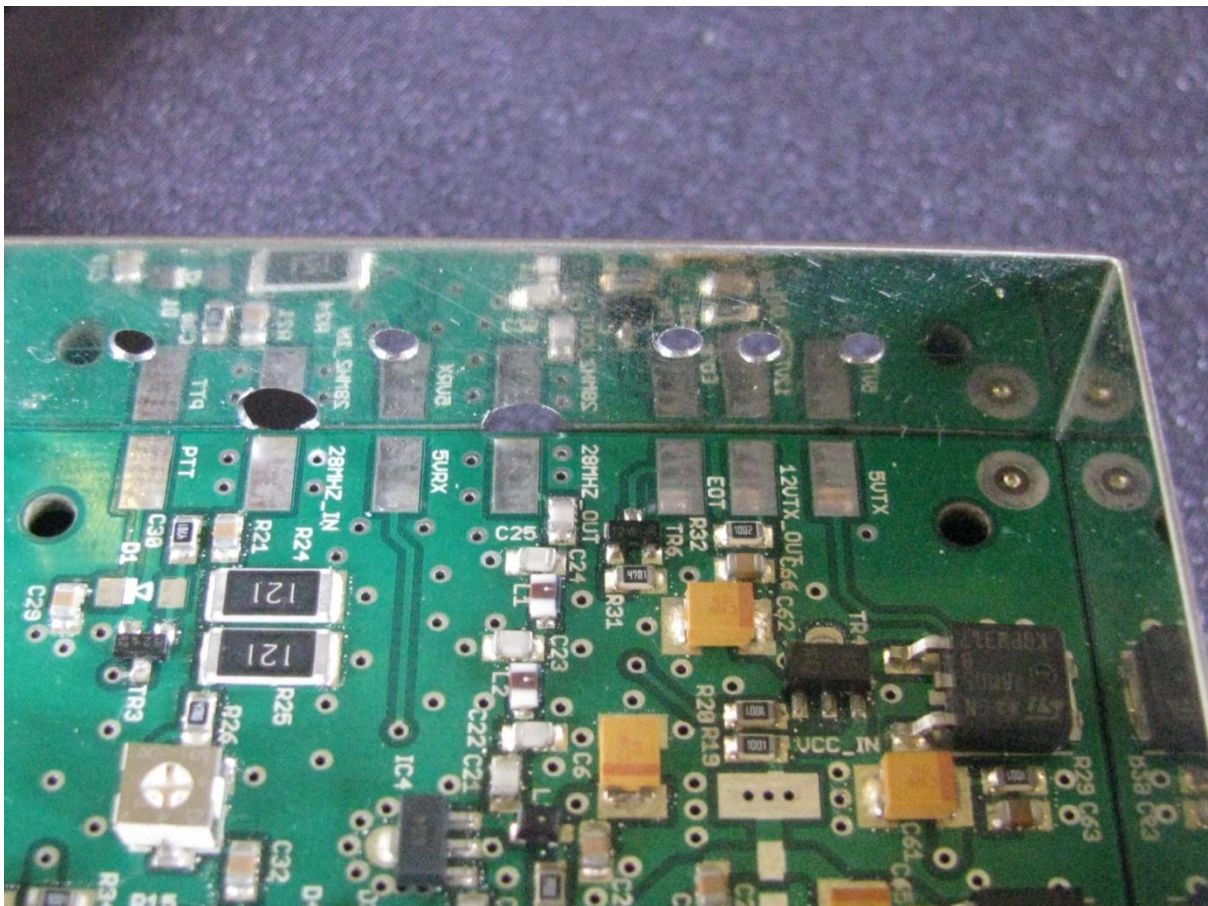


Photo 5 PCB offered up to end wall of box prior to soldering. Note that the R21 and C30 designations are interchanged. The two components ARE in the correct places. Only the designators have been swapped!

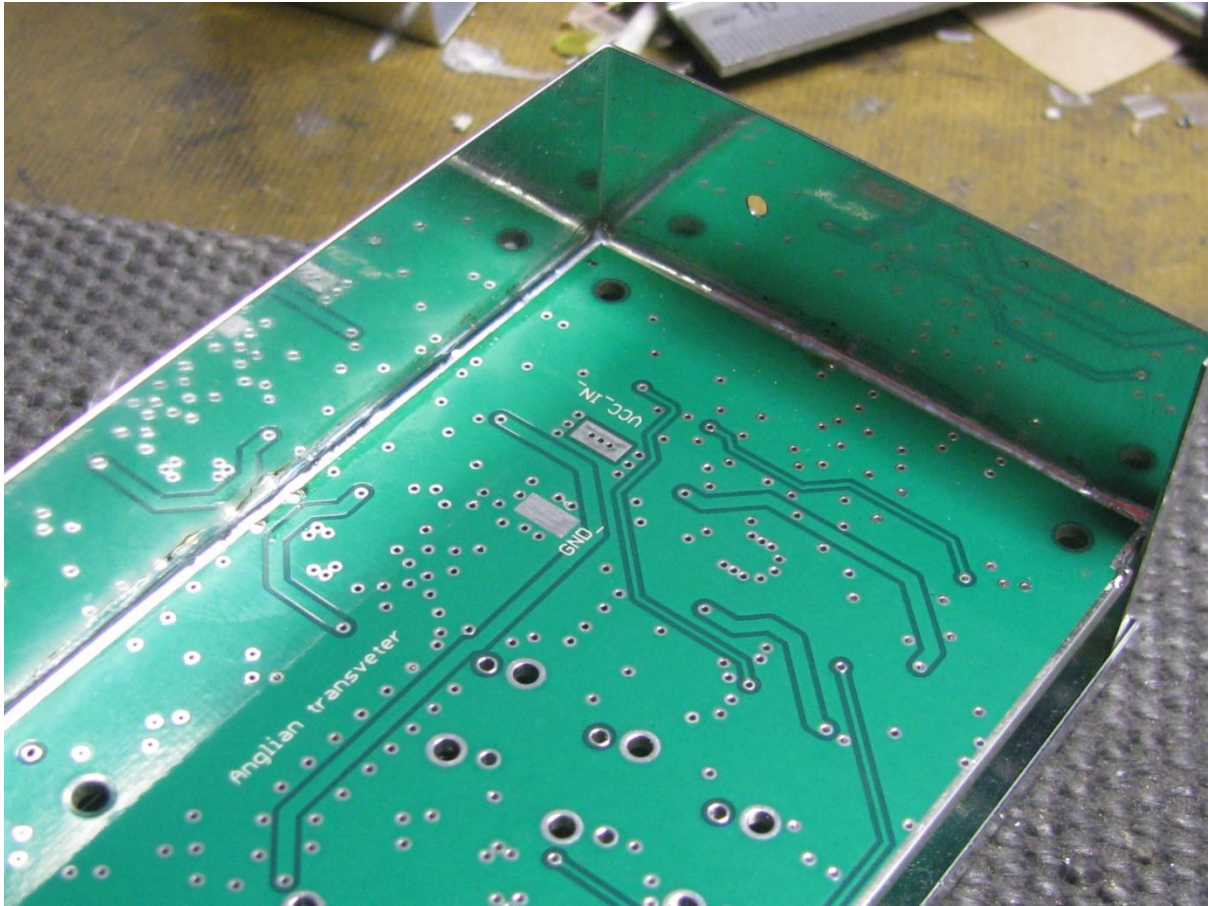


Photo 6 PCB seam soldered to one end of the box

The solder border running around the PCB should be level with the line marked at 22mm below the rim. Tack solder the PCB in two places initially (to the inside of the box). This will allow you to move the PCB if it is not straight. A Weller 50W temperature controlled iron is ideal for seam soldering the PCB and box.

Once you are happy it is level you can complete the seam soldering on both the box end wall and the box side.

Now place the PCB and box side into the lid of the box as shown in **photo 6**. DO NOT SOLDER TO THE LID!

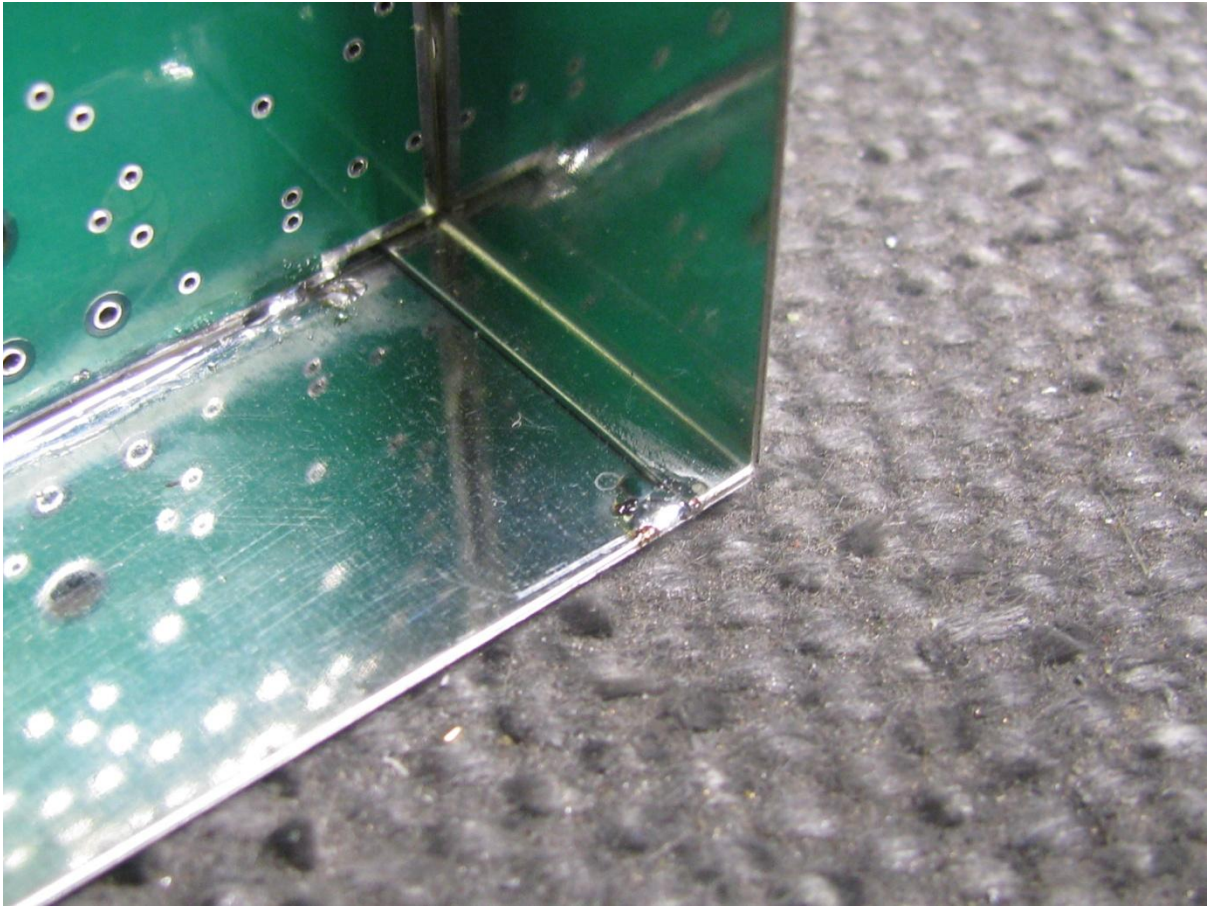


Photo 7 *Second side of box tack soldered*

Carefully slide the second box side into place in the lid.

Check everything is a good fit and all corners are square.

Tack solder the two flange box corners as shown in **photo 7** to add rigidity to the box.

Remove the lid, carefully check that the PCB is level with the '22mm' lines inside the second box side. Seam solder the PCB to the second box side.

Check that the box top and bottom both fit correctly.

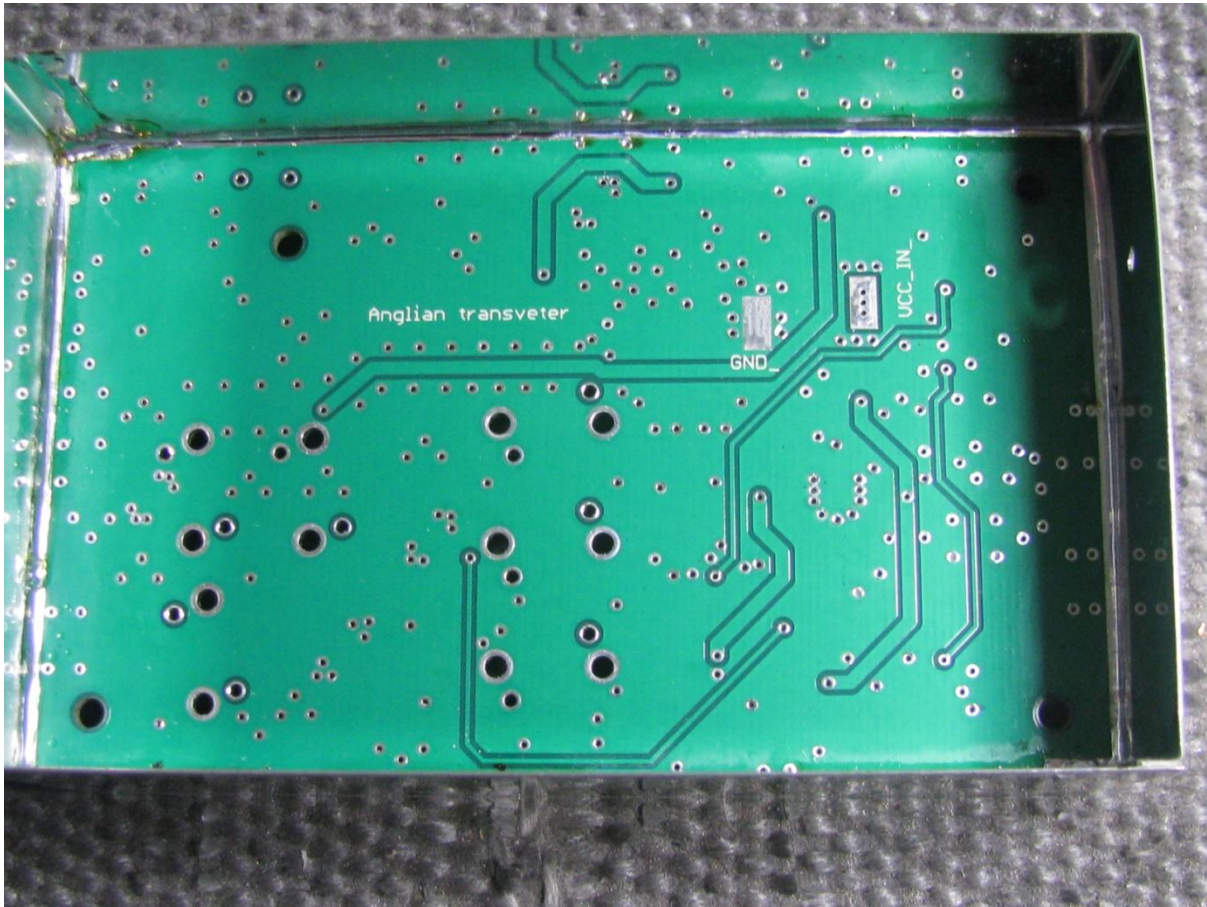


Photo 8 PCB seam soldered into the box. Excuse the spelling mistake!

Soldering the connectors

Prepare the SMA connectors by cutting off the PTFE insulation from the rear of the connector. A Stanley knife is ideal for this. photo **9a**.

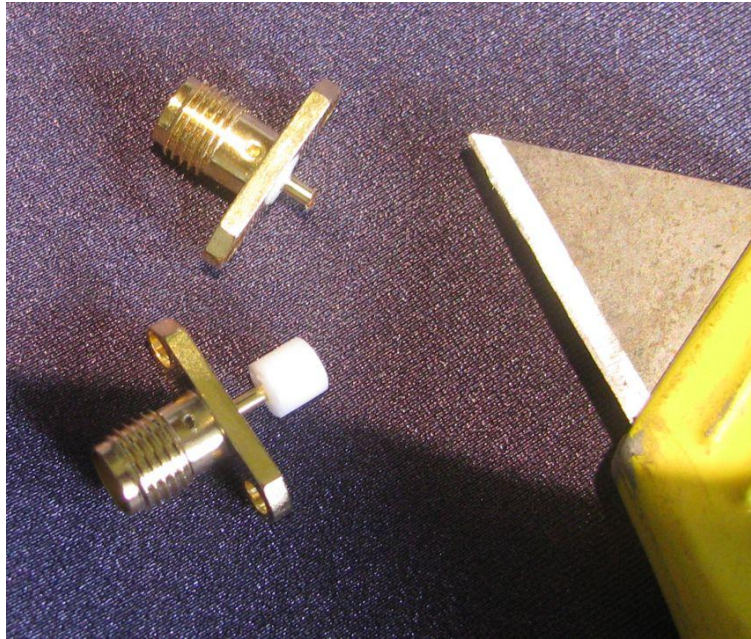


Photo 9a *preparing the connectors*

When all five connectors have been prepared they can be soldered to the outside of the box as shown in **photo 9b**.

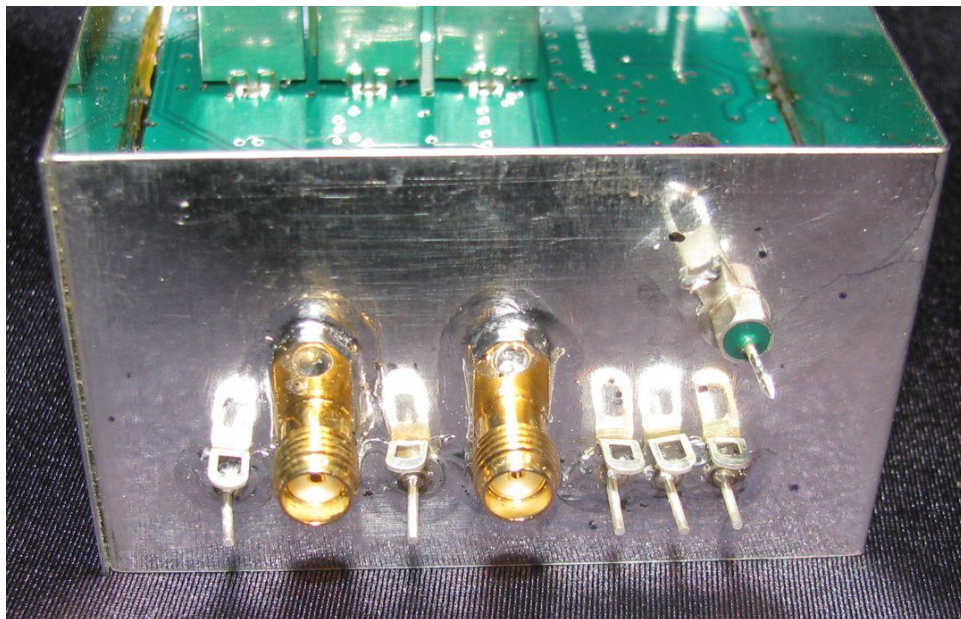


Photo 9b. *the two SMA connectors for the IF connections to the transceiver and the 5 control connections (lower), plus the supply connection (above). The two RF and the LO connectors are on the other end wall of the box.*

I find the easiest way to do this is to tack solder the spill of the connector, through the 4mm hole in the box end, to the pad on the PCB. Try to get the two hole connector flange vertical and the flange

tight against the box and then tack the spill again. You can **gently** rotate the connector to bring it vertical. Make sure that the spill does not rotate and damage the PCB pad.

Repeat for the remaining four connectors.

Soldering the feed-through capacitors

Carefully slip one of the feed-through capacitors through the hole in one of the 2.2mm solder tags. Push the feed-through capacitor through one of the 2mm holes in the box end. Bend the solder tag away from the box. Solder into place. Again, as shown in **photo 9b**.

Repeat for the remaining feed-through capacitors.

soldering the coils and crystal

Five of the 6 Coilcraft coils are mounted with screening cans, but the receiver input coil (L20) does NOT have a screening can. This increases the coil Q and reduce input circuit losses.

Note which end of the coils should go to ground. The top of the coil winding should be at the ground end. Failure to connect this way round may result in excess loss in the tuned circuits due to stray capacitance. **Photos 10a and 10b** show the correct orientation for these coils. Note that the coils have one corner larger than the others. This is the 'hot' end of the coils that goes to the 'top' of the tunes circuits that make up the filter. L20 orientation is with the bulge towards the SPF5043. This is shown in **fig 1**

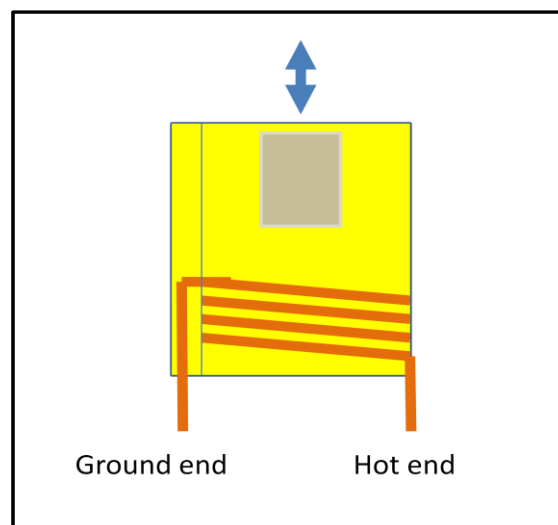


Fig1 Tuneable coil connections

To be sure of the correct orientation, remove the screening cans from these five coils and check that the 'top' of the coil goes to the ground connection pads. After soldering the coils into place solder the screening cans in place.

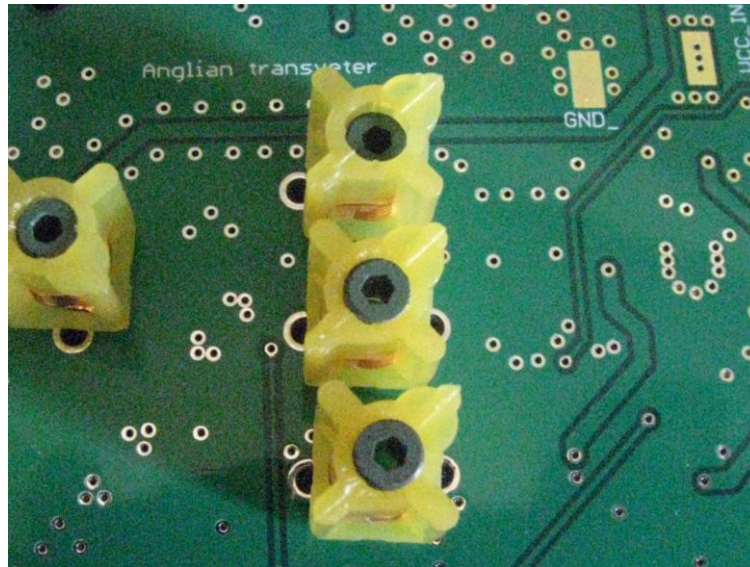


Photo 10a Three pole filter coil orientation. Note the 'bulging' fourth corner.

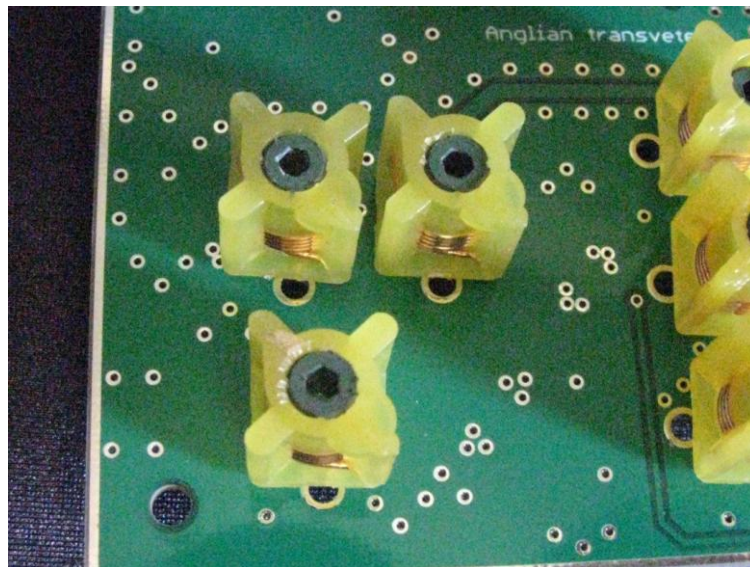


Photo 10b two pole and input filter coil orientation.

Solder the crystal through the holes on the PCB. The crystal case should not be pushed down onto the PCB in order to reduce heat conduction to the crystal can and aid thermal stability. This is shown in **Fig 2**

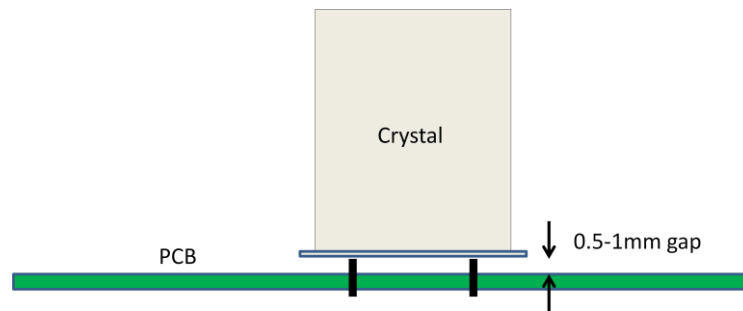


Fig 2 soldering the crystal to the PCB pads

Fitting the trimmers

There are three trimmer capacitors. These were not fitted during the pick and place reflow process. However the parts are larger than the small 0805 parts and so should be easy to solder to the PCB using a soldering iron. Note that some kits have been supplied with three green trimmers. These have the capacitance range 6.5 to 30pF rather than 5 to 20pf. They have been supplied due to a shortage of the 'red' trimmers in mid 2014. Only a few kits have been supplied with green trimmers. The alignment details are identical, whether red or green trimmers are fitted.

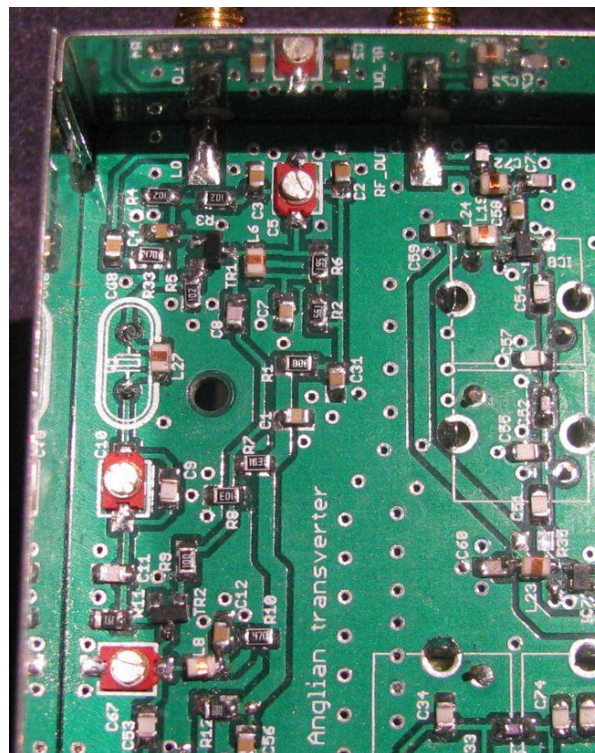
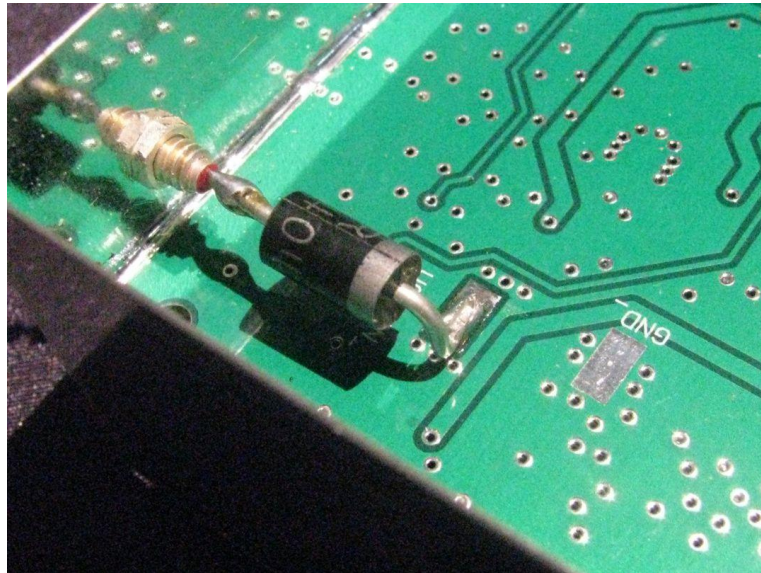


Photo 11 shows the orientation of the three 20pF red trimmers. See note above about green trimmers

Connecting the pads

On the SMD component side of the PCB connect the PTT feed-through capacitor through the 1N4148 diode, D1, to the collector of TR3. The original PCB tracking was wrong and had the diode connected to the base of this transistor. That SMD diode is no longer mounted on the PCB. The cathode or banded end of the leaded diode connects to the feed-through capacitor. Appendix 2 overlay shows the correct place for D1 to connect.

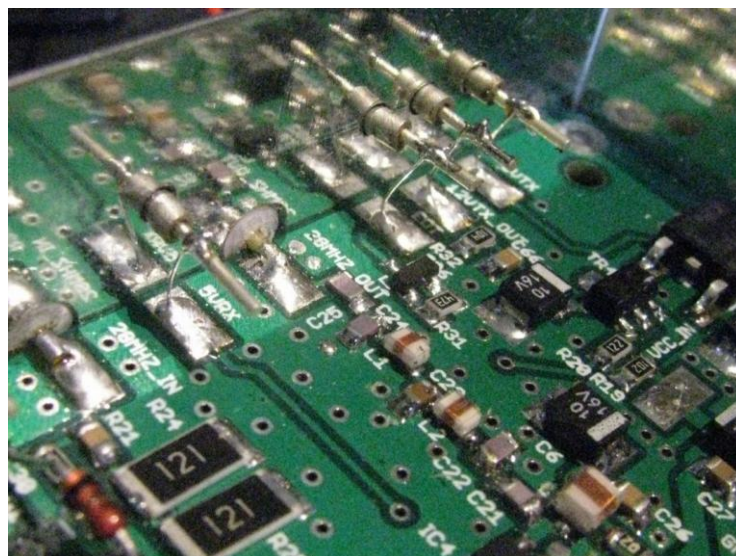
On the other side of the PCB connect the 1N5401 (or similar 3A silicon diode) to the power feed-through capacitor and the power supply input feed-through capacitor. In this case the cathode or banded end of the diode should connect to the Vcc pad on the top of the PCB as shown in [photo 12](#). Note that you should carefully dress the diode leads to allow the diode to fit between the power feed-through capacitor and the Vcc pad.



[Photo 12](#) shows the 1N5401 diode connected from the power feed-through capacitor to the Vcc pad.

Connect the other feed-through capacitors to the adjacent pads (EOT, TX 12V, TX 5V and RX 5V) on the PCB with suitable, short, lengths of insulated wire.

The pads and the 1N4148 diode, D1, is shown in [photo 13](#).



[Photo 13](#) IF pads and connectors soldered as well as the feed-through capacitors and control pads. The 1N4148 can be seen lower left.

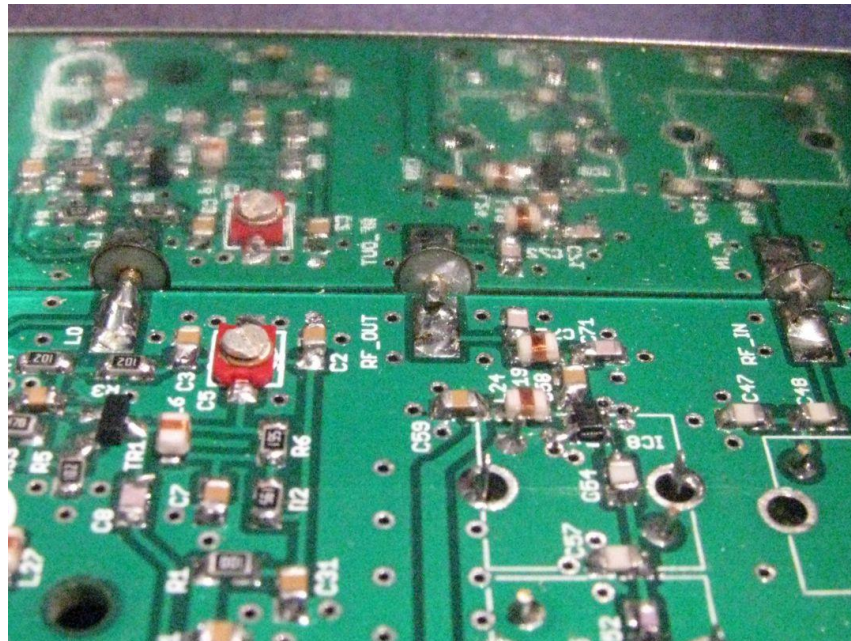


Photo 14 the RF pad to SMA end of the PCB

Test and Alignment

Refer to the schematic circuit diagram in Appendix 1

Connect a 50Ω termination to the receiver (144MHz) input and IF (28MHz) output. You will get more noise with the input terminated in 50Ω than with the input open circuit.

Connect +12v to the power input feed-through capacitor. The supply should be set to current limit at around 0.5A if possible.

Check that the current taken is about 250mA. If significantly more or less you probably have a fault and this must be fixed before proceeding.

Check that there is +8V present at the junction of R1 and C1.

Check that you have +5V at the junction of R30 and C44.

Ground the PTT feed-through and check that there is +5V at the junction of R18 and C50. The total current taken should fall by about 50mA.

Remove the PTT ground.

Switch the power off.

The 0Ω bridge, R14, is will need to be temporarily removed in order to allow the local oscillator power to be measured. This resistor or a short wire link must be in place after the measurement in order for the transverter to work.

Ideally a spectrum analyser set to 116MHz centre frequency with 10MHz span and +30dBm amplitude should be used. However it is possible to do the alignment with a power meter and frequency counter or accurate frequency readout receiver.

Switch the power back on.

Adjust C5 trimmer and C10 trimmer , both red (or green), until you see a strong signal at 116MHz. Adjust C67 (also red or green) to peak the 116MHz output. This should be close to +20dBm (100mW). It may be necessary to go back and re-adjust C5 and C10 as there is some interaction between these three trimmers. Set the frequency as accurately as you can to 116.000.000MHz. An error of 100Hz maximum should be allowed. The three red or green trimmers can be clearly seen in **photo 11**

Switch the power off

Remove the spectrum analyser connection.

Replace R14 or wire link.

Connect a 28MHz receiver to the 28MHz IF output in place of the 50Ω termination.

Tune to 29MHz.

Switch the power back on.

The noise in the receiver should increase. It may still be quite low level at this stage.

Using the **correct** core trimming tool, set the cores of L14, L15 and L16 to one turn below the top of the screening can. The noise should increase slightly. Adjust the core of L15 (middle coil) in by about a turn. The noise should increase noticeably. Note that there is NO SCREENING CAN ON L20!

Adjust L14 and L16 to increase the noise. Re-adjust L15 if necessary.

By careful setting of the cores of these three inductors it should be possible to equalise the noise across the whole of 28 to 30MHz on the receiver.

With the receiver tuned to 28.5MHz, adjust the core of L20 to maximise the noise at this frequency. If you have a noise figure meter it should be possible to adjust the noise figure to around 1.6dB at 144.3MHz with slightly higher noise figure at 28 and 30MHz. It may not be very different!

That is the receive converter aligned.

Connect the spectrum analyser, set to 144MHz centre frequency, 200MHz span, +30dBm reference level, the RF (144MHz) output socket. Do not connect any 28MHz input signal at this stage.

Switch the power on.

Connect a ground to the PTT feed-through capacitor.

The spectrum analyser should show no output. There might be a small, residual, 116MHz output if you check that frequency.

Adjust the TX gain potentiometer, R27, to give maximum attenuation. Note, this will be with the pot fully clockwise.

Connect a 0dBm 29.00MHz input source to the 28MHz IF input. There might be a slight 144MHz output due to IF signal leakage across the attenuator.

Slowly turn the TX gain control clockwise 1/4 turn and as you do so the 144MHz output should increase, slightly. Adjust the cores of L21 and L22 to peak the output. The initial starting positions for the cores should be with the cores just level with the top of the screening cans. The cores will need to be wound in, not out. There will be a broad, but distinct, peak.

Once the output is peaked, continue to adjust the TX gain pot up to a maximum of about +22dBm output. The output increase should be steady without any sign of jumps in level. Widening the spectrum analyser span to 1GHz (starting at 10MHz) should reveal just the 144MHz output plus the second and third harmonic at over 40dB below the 144MHz output, at maximum output.

Reduce the 29MHz IF input and you should find that you can get at least +10dBm output at 144MHz for around -10dBm IF input. If your IF radio only puts out -20dBm then it will be necessary to change the IF attenuator to increase the transverter output, as described later.

Remove the PTT ground

Check that the local oscillator is accurately on 116.000.000MHz by monitoring with an accurately controlled time-base (clock) frequency counter. It may be necessary to remove inductor L27 from across the crystal Q1 in order to achieve precisely the required frequency. This has not been found necessary with any of the crystals in the early run of transverter kits.

Switch off the power.

The transverter is now aligned. It is possible to go back over the these adjustments (what radio amateur wouldn't!) to improve performance slightly. If you don't have access to a spectrum analyser it is HIGHLY recommended that you do find access to one as it would be irresponsible to assume everything is working as it should without properly checking it on the appropriate test equipment. Analysers are often available for this purpose at the regular UK Microwave Round Tables.

Interfacing the Anglian transverter to the HF transceiver

Drive level

Ideally the Anglian transverter should be driven with a 28MHz level of 0dBm. Full transverter output will be achieved at this level. For those rigs with lower output levels, such as the ICOM range, it is possible to increase the transmit gain of the Anglian by removing the two 120Ω resistors R24 and R25, and reducing the value of R26 to 10R. This may not give the full transmit output from the Anglian, but it will be sufficient to drive most RF MOS modules to full output.

Radios that will not give less than 5W output at 28MHz will require the use of an external attenuator of at least 10dB and preferably 20dB. This must be mounted external to the transverter and in the transmit IF lead.

Single coax IF

It is possible to simply combine the two IF ports on the Anglian using a 3dB splitter, such as one of those from MCL, to bring the two ports to a single HF radio IF port like the ICOM PRO range. This has been done quite successfully with an ICOM 756 Pro 3 and I can personally confirm that it works well and the power output can still be adjusted using the Pro 3 power control.

It should also be possible to re-combine the 28MHz IF input and output from an Elecraft K3 so that the Anglian can be located remotely from the K3 with just a single coax connection. Although the PTT connection could be made over the IF COAX it will require some DC blocking to work correctly. It is probably better to use a 'hard' wired PTT connection. There will be more information on interfacing the Anglian in another article to be added to this site.

Transmit switching

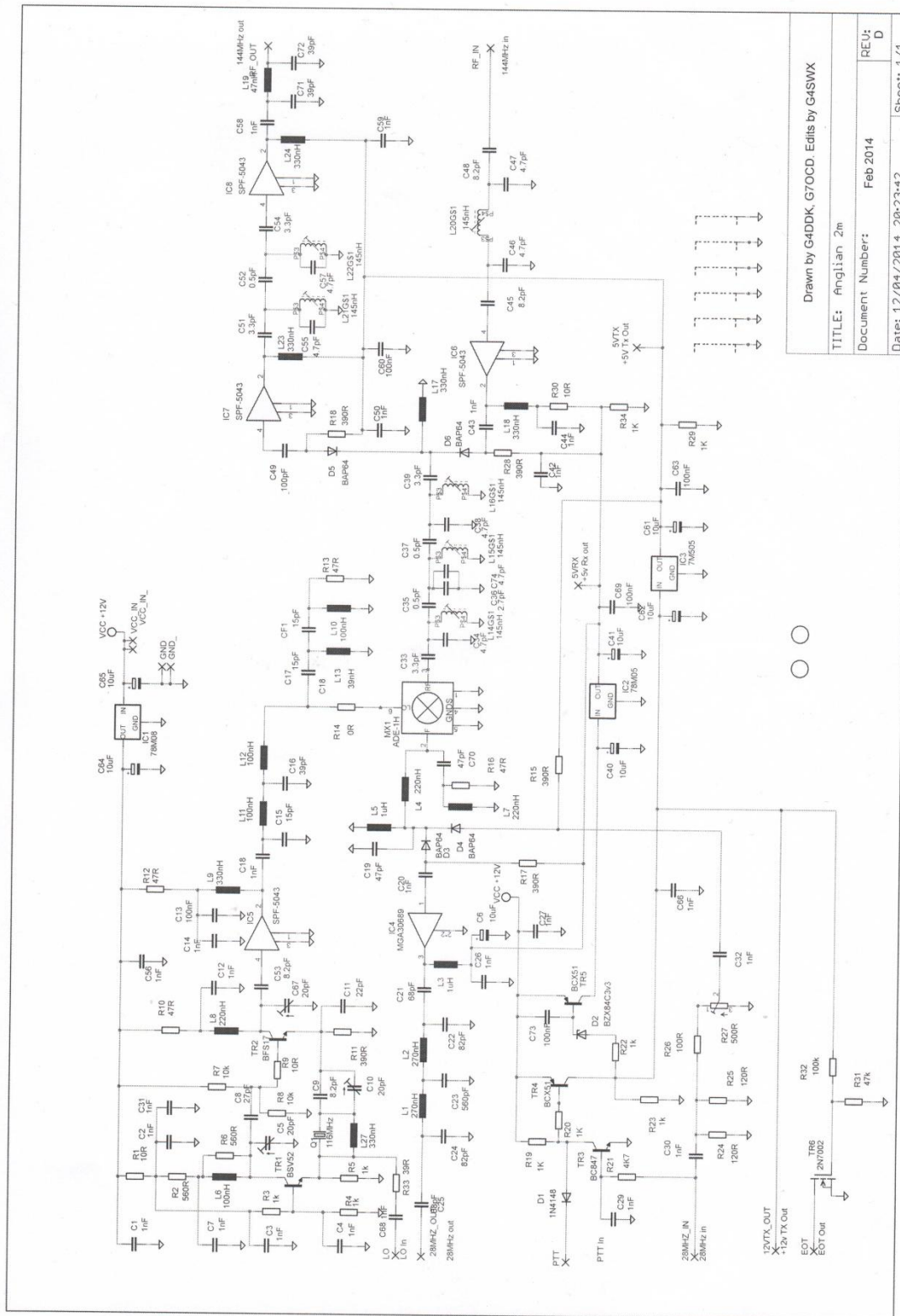
The preferred method of switching is to apply a ground to the Anglian PTT input. However, it is also possible to apply a small (<12V) high impedance voltage to the transmit IF port to cause the switching to occur. This is more usual with 144MHz IF radios, but is provided for where it might be needed at 28MHz.

Document History

Date	issue	changes
1 May 2014	0.1	Initial document
2 May 2014	0.2	Extra photos
4 May 2014	0.3	Some small text changes
5 May 2014	0.5	Schematic diagram change and some small text changes
6 May 2014	1.0	First issue for web page
10 July 2014	1.1	Some small text changes, clarifications and additions

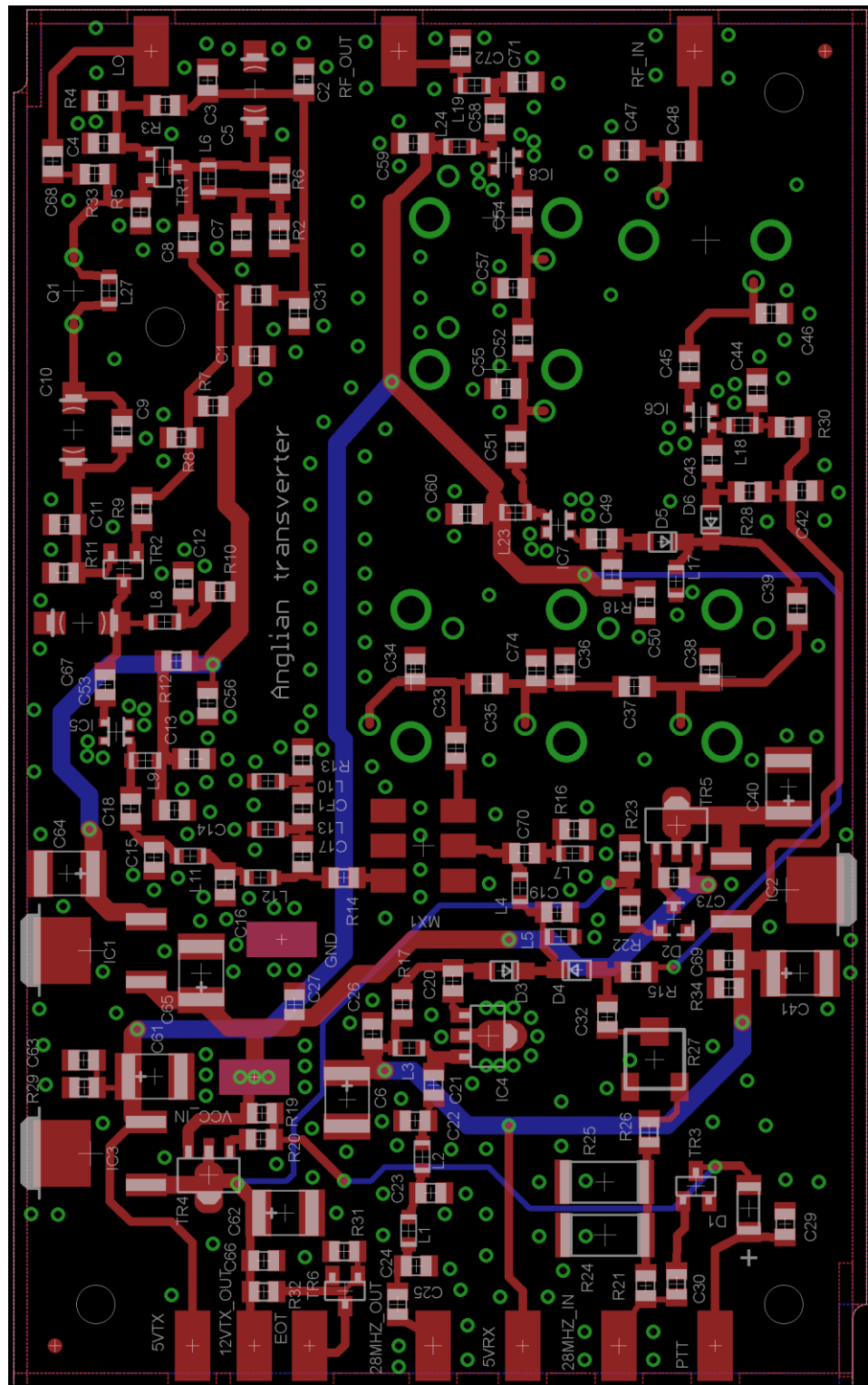
©G4DDK 2014

Appendix 1



Drawn by G4DDK, G7OCD. Edits by G4SWX		
TITLE: Anglian 2m		
Document Number:	Feb 2014	REU: D
Date: 12/04/2014	20:23:42	Sheet: 1 / 1

Schematic circuit diagram of the Anglian 144MHz transverter.



Anglian 144MHz overlay